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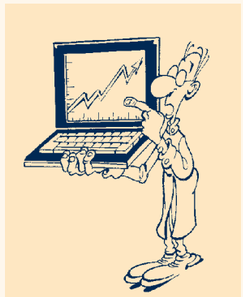

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Foreword

When the United Nations Environment Programme and the World Meteorological Organization launched the Intergovernmental Panel on Climate Change (IPCC) in 1988, none of us could imagine how effective and influential its work would become.

Everyone agrees that environmental policy must be based on sound science. Prudent policy choices must be rooted in rigorous, careful and balanced analyses of the best scientific and technical information.

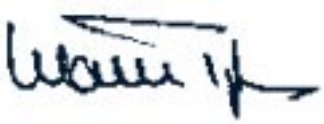
The IPCC has shown the way, developing a process which engages hundreds of the world's leading experts in reviewing the most up-to-date, peer-reviewed literature on the scientific and technical aspects of climate change. The IPCC integrates its assessments into a policy-relevant format universally accepted as a basis for decision-making by the 185 member governments of the United Nations Framework Convention on Climate Change.

The IPCC's three-volume Third Assessment Report was finalized in early 2001. Its message is clear: intensive climate research and monitoring gives scientists much greater confidence in their understanding of the causes and consequences of global warming. The Assessment presents a compelling snapshot of what the earth will probably look like in the late 21st century, when a global warming of 1.4 – 5.8°C (2.5-10.4°F) will influence weather patterns, water resources, the cycling of the seasons, ecosystems, extreme climate events, and much more. Even greater changes are expected in the more distant future.

The international community is working together to minimize these risks through the 1992 Convention and its 1997 Kyoto Protocol. Undoubtedly the most complex and ambitious agreements on environment and sustainable development ever adopted, the climate change treaties set out the principles, institutions, and rules for addressing global warming. They establish a regime that is dynamic and action-oriented. At the same time, it is flexible enough to evolve over the coming decades in response to changes in the political landscape and in scientific understanding.

With this global process now in place, governments need to move forward quickly to design and carry out their national climate change policies. The IPCC Assessment confirms that well-designed, market-oriented policies can reduce emissions and the costs of adapting to the unavoidable impacts of climate change while simultaneously generating significant economic benefits. These benefits include more cost-effective energy systems, more rapid technological innovation, reduced expenditures on inappropriate subsidies, and more efficient markets. Cutting emissions can also reduce damage from local environmental problems, including the health effects of air pollution.

The IPCC and the Climate Change Convention both demonstrate that the peoples of the world can tackle global problems together by collaborating through the United Nations system. The fact sheets in this information kit seek to summarize in simple language the most up-to-date findings of the IPCC and the most recent developments under the Convention and Protocol. I hope you find them useful in your own work.



Klaus Töpfer
Executive Director
United Nations Environment Programme (UNEP)

An introduction to climate change

◆ **Human activities are releasing greenhouse gases into the atmosphere.** Carbon dioxide is produced when fossil fuels are used to generate energy and when forests are cut down and burned. Methane and nitrous oxide are emitted from agricultural activities, changes in land use, and other sources. Artificial chemicals called halocarbons (CFCs, HFCs, PFCs) and other long-lived gases such as sulphur hexafluoride (SF_6) are released by industrial processes. Ozone in the lower atmosphere is generated indirectly by automobile exhaust fumes and other sources.

◆ **Rising levels of greenhouse gases are already changing the climate.** By absorbing infrared radiation, these gases control the way natural energy flows through the climate system. In response to humanity's emissions, the climate has started to adjust to a "thicker blanket" of greenhouse gases in order to maintain the balance between energy arriving from the sun and energy escaping back into space. Observations show that global temperatures have risen by about 0.6 °C over the 20th century. There is new and stronger evidence that most of the observed warming over the last 50 years is attributable to human activities.

◆ **Climate models predict that the global temperature will rise by about 1.4 – 5.8°C by the year 2100.** This change would be much larger than any climate change experienced over at least the last 10,000 years. The projection is based on a wide range of assumptions about the main forces driving future emissions (such as population growth and technological change) but does not reflect any efforts to control emissions due to concerns about climate change. There are many uncertainties about the scale and impacts of climate change, particularly at the regional level. Because of the delaying effect of the oceans, surface temperatures do not respond immediately to greenhouse gas emissions, so climate change will continue for hundreds of years after atmospheric concentrations have stabilized.

◆ **Climate change is likely to have a significant impact on the global environment.** In general, the faster the climate changes, the greater will be the risk of damage. The mean sea level is expected to rise 9 - 88 cm by the year 2100, causing flooding of low-lying areas and other damage. Other effects could include an increase in global precipitation and changes in the severity or frequency of extreme events. Climatic zones could shift poleward and vertically, disrupting forests, deserts, rangelands, and other unmanaged ecosystems. As a result, many will decline or fragment, and individual species could become extinct.

◆ **Human society will face new risks and pressures.** Food security is unlikely to be threatened at the global level, but some regions are likely to experience food shortages and hunger. Water resources will be affected as precipitation and evaporation patterns change around the world. Physical infrastructure will be damaged, particularly by sea-level rise and by extreme weather events. Economic

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activities, human settlements, and human health will experience many direct and indirect effects. The poor and disadvantaged are the most vulnerable to the negative consequences of climate change.

◆ **People and ecosystems will need to adapt to future climatic regimes.** Past and current emissions have already committed the earth to some degree of climate change in the 21st century. Adapting to these effects will require a good understanding of socio-economic and natural systems, their sensitivity to climate change, and their inherent ability to adapt. Fortunately, many strategies are available for adapting to the expected effects of climate change.

◆ **Stabilizing atmospheric concentrations of greenhouse gases will demand a major effort.** Without emissions-control policies motivated by concerns about climate change, atmospheric concentrations of carbon dioxide are expected to rise from today's 367 parts per million to 490 – 1,260 ppm by the year 2100. This would represent a 75 – 350% increase since the year 1750. Stabilizing concentrations at, for example, 450 ppm would require world-wide emissions to fall below 1990 levels within the next few decades. Given an expanding global economy and growing populations, this would require dramatic improvements in energy efficiency and fundamental changes in other economic sectors.

◆ **The international community is tackling this challenge through the Climate Change Convention.** Adopted in 1992 and now boasting over 185 members, the Convention seeks to stabilize atmospheric concentrations of greenhouse gases at safe levels. It commits all countries to limit their emissions, gather relevant information, develop strategies for adapting to climate change, and cooperate on research and technology. It also requires developed countries to take measures aimed at returning their emissions to 1990 levels.

◆ **The Kyoto Protocol would require governments to take even stronger action.** In 1997, the Parties to the Convention agreed by consensus that developed countries should accept a legally binding commitment to reduce their collective emissions of six greenhouse gases by at least 5% compared to 1990 levels by the period 2008-2012. The Protocol also establishes an emissions trading regime and a "clean development mechanism". However, the Protocol has not yet received enough ratifications to enter into force.

◆ **Many options for limiting emissions are available in the short- and medium-term.** Policymakers can encourage energy efficiency and other climate-friendly trends in both the supply and consumption of energy. Key consumers of energy include industries, homes, offices, vehicles, and agriculture. Efficiency can be improved in large part by providing an appropriate economic and regulatory framework for consumers and investors. This framework should promote cost-effective actions, the best current and future technologies, and "no regrets" solutions that make economic and environmental sense irrespective of climate change. Taxes, regulatory standards, tradable emissions permits, information programmes, voluntary programmes, and the phase-out of counterproductive subsidies can all play a role. Changes in practices and lifestyles, from better urban transport planning to personal habits such as turning out the lights, are also important.

◆ **Reducing uncertainties about climate change, its impacts, and the costs of various response options is vital.** In the meantime, it will be necessary to balance concerns about risks and damages with concerns about economic development. The prudent response to climate change, therefore, is to adopt a portfolio of actions aimed at controlling emissions, adapting to impacts, and encouraging scientific, technological, and socio-economic research.

The greenhouse effect

◆ **The earth's climate is driven by a continuous flow of energy from the sun.** This energy arrives mainly in the form of visible light. About 30% is immediately scattered back into space, but most of the remaining 70% passes down through the atmosphere to warm the earth's surface.

◆ **The earth must send this energy back out into space in the form of infrared radiation.** Being much cooler than the sun, the earth does not emit energy as visible light. Instead, it emits infrared, or thermal radiation. This is the heat thrown off by an electric fire or grill before the bars begin to glow red.

◆ **"Greenhouse gases" in the atmosphere block infrared radiation from escaping directly from the surface to space.** Infrared radiation cannot pass straight through the air like visible light. Instead, most departing energy is carried away from the surface by air currents, eventually escaping to space from altitudes above the thickest layers of the greenhouse gas blanket.

◆ **The main greenhouse gases are water vapour, carbon dioxide, ozone, methane, nitrous oxide, and halocarbons and other industrial gases.** Apart from the industrial gases, all of these gases occur naturally. Together, they make up less than 1% of the atmosphere. This is enough to produce a "natural greenhouse effect" that keeps the planet some 30°C warmer than it would otherwise be – essential for life as we know it.

◆ **Levels of all key greenhouse gases (with the possible exception of water vapour) are rising as a direct result of human activity.** Emissions of carbon dioxide (mainly from burning coal, oil, and natural gas), methane and nitrous oxide (due mainly to agriculture and changes in land use), ozone (generated by automobile exhaust fumes and other sources) and long-lived industrial gases such as CFCs, HFCs, and PFCs are changing how the atmosphere absorbs energy. Water vapour levels may also be rising because of a "positive feedback". This is all happening at an unprecedented speed. The result is known as the "enhanced greenhouse effect".

◆ **The climate system must adjust to rising greenhouse gas levels to keep the global "energy budget" in balance.** In the long term, the earth must get rid of energy at the same rate at which it receives energy from the sun. Since a thicker blanket of greenhouse gases helps to reduce energy loss to space, the climate must change somehow to restore the balance between incoming and outgoing energy.

◆ **This adjustment will include a "global warming" of the earth's surface and lower atmosphere.** But this is only part of the story. Warming up is the simplest way for the climate to get rid of the extra energy. But even a small rise in temperature will be accompanied by many other changes: in cloud cover and wind

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patterns, for example. Some of these changes may act to enhance the warming (positive feedbacks), others to counteract it (negative feedbacks).

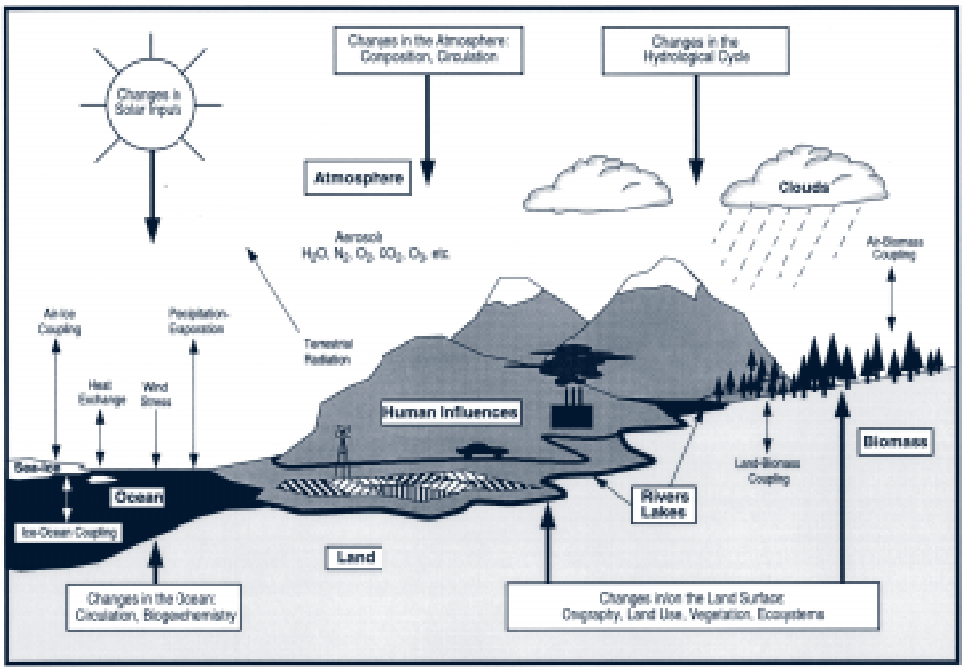
◆ **Meanwhile, man-made aerosols have an overall cooling effect.** Sulphur emissions from coal- and oil-fired power stations and the burning of organic material produce microscopic particles that can reflect sunlight back out into space and also affect clouds. The resultant cooling partly counteracts greenhouse warming. These aerosols, however, remain in the atmosphere for a relatively short time compared to the long-lived greenhouse gases, so their cooling effect is localized. They also cause acid rain and poor air quality, problems that need to be addressed. This means we should not rely indefinitely on the cooling effect of aerosols.

◆ **Climate models estimate that the global average temperature will rise by about 1.4 – 5.8°C (2.5 – 10.4°F) by the year 2100.** This projection uses 1990 as a baseline and assumes that no policies are adopted for minimizing climate change. It also takes into account climate feedbacks and the effects of aerosols as they are presently understood.

◆ **Past emissions have already committed us to some climate change.** The climate does not respond immediately to emissions. It will therefore continue to change for hundreds of years even if greenhouse gas emissions are reduced and atmospheric levels stop rising. Some important impacts of climate change, such as a predicted rise in sea level, will take even longer to be fully realized.

◆ **There is new and stronger evidence that climate change has already begun.** The climate varies naturally, making it difficult to identify the effects of rising greenhouse gases. However, an increasing body of observation now presents a collective picture of a warming world. For example, the pattern of temperature trends over the past few decades resembles the pattern of greenhouse warming predicted by models; these trends are unlikely to be due entirely to known sources of natural variability. Many uncertainties remain, however, such as how changes in cloud cover will influence future climate.

A schematic illustration of the climate system



Source: IPCC 1995.

Greenhouse gases and aerosols

◆ **Greenhouse gases (GHGs) control energy flows in the atmosphere by absorbing infra-red radiation emitted by the earth.** They act like a blanket to keep the earth's surface some 20°C warmer than it would be if the atmosphere contained only oxygen and nitrogen. The trace gases that cause this natural greenhouse effect comprise less than 1% of the atmosphere. Their levels are determined by a balance between "sources" and "sinks". Sources are processes that generate greenhouse gases; sinks are processes that destroy or remove them. Apart from industrial chemicals like CFCs and HFCs, greenhouse gases have been present naturally in the atmosphere for millions of years. Humans however, are affecting greenhouse gas levels by introducing new sources or by interfering with natural sinks.

◆ **The largest contributor to the natural greenhouse effect is water vapour.** Its presence in the atmosphere is not directly affected by human activity. Nevertheless, water vapour matters for climate change because of an important "positive feedback". Warmer air can hold more moisture, and models predict that a small global warming would lead to a rise in global water vapour levels, further adding to the enhanced greenhouse effect. Because modeling climate processes involving clouds and rainfall is particularly difficult, the exact size of this crucial feedback remains uncertain.

◆ **Carbon dioxide is currently responsible for over 60% of the "enhanced" greenhouse effect.** This gas occurs naturally in the atmosphere, but burning coal, oil, and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Likewise, deforestation releases carbon stored in trees. Current annual emissions amount to over 23 billion metric tons of carbon dioxide, or almost 1% of the total mass of carbon dioxide in the atmosphere.

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